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Physics and applications"

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Editorial

Special Issue on "Metasurfaces: Physics and Applications"

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Metasurfaces, the two-dimensional analog of metamaterials, have been attracting progressively increasing attention in recent years due to their planar configurations and thus ease of fabrication while enabling unprecedented control in optical fields [1–4]. The phase, amplitude, polarization, helicity, and even angular momentum of the reflected or transmitted optical fields can be controlled at will by tailoring optically thin planar arrays of resonant subwavelength elements arranged in a periodic or aperiodic manner. As a result, numerous applications and fascinating devices have been realized by designed planar metasurfaces, including beam deflectors [5–9], wave plates [10–13], flat lenses [14–20], holograms [21–25], surface wave couplers [26–30], and freeform metasurfaces [31–33].

This special issue is launched to provide a possibility for researchers in the area of metasurfaces to highlight the most recent exciting developments and discuss different metasurface configurations in depth, so as to further promote practical applications of metasurfaces. There are 12 papers selected for this special issue, representing fascinating progress and potential applications in the area of metasurfaces. This collection includes three review papers in total, which focus on a few specific branches of metasurface-based applications [34–36]. Lei Zhou and co-workers present a concise review on the development of multifunctional metasurfaces based on merging concept and anisotropic single-structure meta-atoms [34]. This is a timely overview article, since integrating multiple diversified functionalities into a single and ultra-compact device has become an emerging research area in photonics. The second review paper authored by Wei E.I. Sha and co-workers comprehensively discusses the recent progress in geometric-phase-based metasurfaces for orbital angular momentum (OAM) generation and detection [35]. The last review paper from Bozhevolnyi's group focuses on the fundamentals and recent developments within metasurface-based polarimeters, which can detect the polarization state of an incident beam in one shot with a compact single device [36]. Regarding the other nine research papers, the following metasurface-based application areas are specifically addressed:

Metasurface-based microwave antennas: This special issue contains a series of works on metasurface-based antennas operating in the microwave range, which is an important application of metasurfaces. Long Li and co-workers have utilized well-designed metasurfaces to replace the conventional bulk antennas and demonstrated coherent computational imaging [37], high-order harmonic suppression [38], and electromagnetic power harvesting [39]. Additionally, novel metasurface-based antennas have been proposed with improved characteristics, such as the crossbar fractal microstrip [40] and elliptical patch with cross-shaped aperture [41].

Coding metasurface for beam-steering: This special issue includes two excellent examples of microwave coding metasurfaces, of which one is devoted to wide-angle beam-steering based on 1-bit digital reconfigurable reflective metasurfaces [42], and the other one reports the broadband radar cross-section reduction with linear polarization conversion metasurfaces [43].

Metasurface-based spectrometer: One paper presents a theoretical investigation of an off-axis metalens-based spectrometer by addressing the influences of structural parameters on the effective spectral range and spectral resolution [44]. This study outlines an important way to design and integrate planar metasurface-based spectrometers for various practical applications.

Metasurface-based waveguide: Vladimir P. Drachev and co-workers have demonstrated a metasurface-based waveguide composed of magnetic gratings with effective strips, where anisotropy in the effective parameters is introduced, providing thereby an additional flexibility to control the polarization- and angular-dependent optical response [45].

In summary, this special issue contains a series of excellent research work on metasurfaces, covering a wide area of application-oriented meta-devices. This collection of 12 papers is highly recommended and believed to benefit readers in various aspects.

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